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GOLDFISH: THEIR CARE IN SMALL AQUARIA AND PONDS [1]

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Contents

	Page
troduction	1
itable form of aquaria	2
itable aquarial plants	2
lanced aquarium	3
cation of aquarium	4
Water	5
Temperature	5
Prevention of acid condition	6
od	6
seases and their treatment	7
White fungus	8
Fin congestion and tail rot	8
ndigestion	9
chthyophthirius	9
How to distinguish sex	10
Rearing young goldfish	10
Aquarium cement	12
Ponds	12
Garden pools	13
The goldfish as a mosquito exterminator	14
Sterilizing	15
Introduction of new fishes	15
Conclusion	15
Bibliography	15

INTRODUCTION

The goldfish is a member of the carp family, and while its brilliant olors have become fairly well established through selective breedng the scale varieties, which include the common goldfish (*Carasus auratus*), assume the colors of the carp at first and change, when ney are from 3 to 6 months old, to gold, white, or black. Through lective breeding in China, Korea, and Japan, numerous fancy reeds of goldfish have been produced and are now on the market.

Although the Bureau of Fisheries neither propagates nor disributes ornamental fish, the need of a publication for use in answerng the numerous inquiries concerning the care of goldfish has been pparent for some time. It is the aim of this article to set forth riefly such practical advice as appears necessary for the amateur quarist.

The bureau is concerned with the propagation of the food and ame fishes only, and the only literature it has pertaining to goldfish ther than this publication is Economic Circular No. 68, entitled Goldfish Industry," which contains a list of goldfish breeders and obbers. Excellent advice on the breeding of goldfish may be obained by consulting current publications on that subject. (See ibliography.) The bureau does not serve as a medium for adver-

[1] This paper is a revision and enlargement of Bureau of Fisheries Document No. 980, Goldfish: Their care in small aquaria and ponds." Approved for publication July 1, 31.

tising goldfish or aquarium accessories. Publications devoted to aquarium fishes and related subjects contain advertisements of dealers in goldfish, aquatic plants, and in fact everything that is needed by the aquarist.

In the preparation of this publication the following authorities have been freely consulted: Mulerett, Innes, Mellen, and Aquatic Life. (See Bibliography.)

SUITABLE FORM OF AQUARIUM

Because of its narrow neck the so-called fish globe is not adapted to keeping goldfish in a comfortable and healthy state, its small amount of water surface not permitting the process of absorption of air on a scale sufficient for the well-being of the fish. Another objectionable feature of the globe lies in its reflection and refraction of light rays, which tends to make the fish nervous and uneasy. An aquarium with straight sides is the most suitable for goldfish. It should be of rectangular shape and of equal width at the top and bottom. The rectangular battery jar, which may be purchased in the 5-gallon size, will give good results. The depth of water should be about the same as the width of the aquarium, and the bottom should be covered with clean sand and gravel to the depth of 1½ inches. Ordinary washed sand and pebbles are best for this purpose, as the more desirable aquarial plants draw most of their nourishment from the water and require merely an anchorage. In order to insure an abundant air supply, plants of high oxygenating powers should be selected for the aquarium.

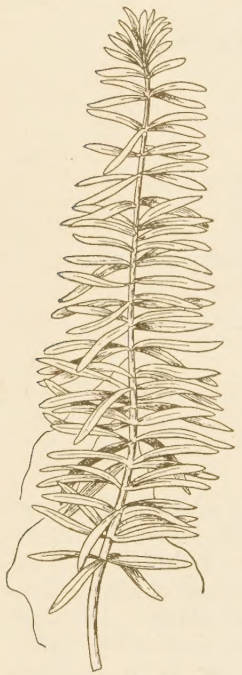

FIGURE 1.—Cultivated anacharis. (From "Goldfish varieties and tropical aquarium fishes" by Wm. T. Innes)

SUITABLE AQUARIAL PLANTS

Among the most suitable plants for an aquarium are anacharis and fanwort, also known as Elodea and Philotria. Anacharis, *Anacharis canadensis* (fig. 1) is a good oxygenator and at the same time provides forage for goldfish. Fanwort, *Cabomba caroliniana* (fig. 2), is a very hardy species and thrives well in small aquaria. It is evergreen, will grow from cutting, especially the forked joints, and a branch planted in the sand at the bottom of an aquarium will produce roots. These plants are very common, and supplies can usually be purchased from goldfish dealers. Other desirable aquarial plants are willow moss, *Fontinalis antipyretica* (fig. 3), and arrowhead, *Sagittaria natans* (fig. 4). Very beautiful aquatic gardens may be made by a proper selection of plants. Ludwigia, *Ludwigia glandulosa* (fig. 5), is highly prized for its fine appearance in the aquarium and is easily propagated from cuttings. *Herpestis amplexicaulus* (fig. 6) is considered the best of recent additions to aquarium plants. When out of water, it has a faint pleasant odor. It is native of ponds in the southeastern United States.

BALANCED AQUARIUM

When the relations of plant life and animal life in an aquarium re properly proportioned, the aquarium is said to be self-sustaining r balanced, and under such a condition the water requires no change. 'illing in to make up for what has evaporated is all that is neces- ary; or, if preferred, about half the water may be drawn off through siphon and a similar amount of fresh, aerated water added. Dur- ng very warm weather this will probably have to be done about once month. If the water should become vitiated at any time, the quarium must be thoroughly cleansed and the entire water supply enewed, the fish first having been removed to another vessel. When sh become restless and rise to the surface of the vater to breathe it indicates that the oxygen sup- ly in the aquarium in insufficient. Relief may e given them by dipping up and pouring back ome of the water.

A small aquarium can not sustain much life. 'ishes, like human beings, can not thrive in rowded habitations, and thousands of goldfish ave been lost by the overstocking of aquaria. 'he number that can be maintained in healthful ondition in a 5-gallon vessel will depend upon s location and shape, the water temperature, haracter of the plant life, size of the fish, and he amount of light admitted.

It is better for beginners to start with a few of he hardier varieties of goldfish until the funda- nental principles of aquarium keeping are under- tood. When common goldfish can be kept with o losses, it is time to branch out and undertake he keeping of the more interesting breeds.

A well-balanced aquarium of 5-gallon capacity s capable of maintaining 2 goldfish, each 2 inches ong exclusive of tail, 1 frog tadpole, and 4 snails.)ne-fourth of the bottom area should be planted vith aquatic vegetation, the ends or roots to be mbedded from 1 to 1½ inches in the sand or ravel, and the plants evenly distributed over the ntire surface to admit light and provide for the ree movement of the fish. In choosing the snails, elect species that do not feed on plants. The best nes are the Planorbis and Vivipara. Snails help to keep down the rowth of algæ, while the tadpole acts as a scavenger, consuming all aste matter in the aquarium. When about to enter the frog stage ne tadpole must be provided with a resting place on the surface of ne water; otherwise it will drown. In a 5-gallon aquarium two andsome specimens of fringe-tail goldfish will make a fine appear- nce. Once or twice a week the inside surface of the front glass nould be cleaned to prevent obstruction of the view by accumula- ons of algæ. For this purpose a flat sponge or piece of felt attached o the flattened end of a stick will be effective. Sediment may be emoved by a glass dip tube or rubber siphon.

FIGURE 2.—Cabomba. (From "Goldfish varieties and tropical aquarium fishes" by Wm. T. Innes)

A 5-gallon aquarium is the minimum size recommended, but when it is possible a larger vessel should be used. A tank 24 inches long, 12 inches wide, and 15 inches high, with a capacity of 18 gallons, makes a suitable aquarium for a parlor or living room. A receptacle of that size should maintain 8 two-inch fish of different types and varieties, 2 tadpoles, and 10 snails. When larger aquaria are used, the number of fishes, scavengers, and plants may be increased proportionately. If the fish are larger, their number should be correspondingly reduced. A good rule in stocking an aquarium is to allow 1 gallon of water to each inch of fish. Maintenance of goldfish under conditions less favorable than these is possible by making frequent changes of water.

FIGURE 3.—*Fontinalis antipyretica.* (From "Goldfish varieties and tropical aquarium fishes" by Wm. T. Innes)

To state definitely just how many inches of fish can be held in an aquarium or pool of a given size one would have to take into consideration several factors, such as the number and kind of aquatic plants, water temperature, food supply, and the general care that the aquarium or pool receives.

In a well-balanced indoor aquarium the writer has been successful in holding 12 fish, averaging 2 inches in length, in 12 gallons of water at the normal living-room temperature during the entire winter. These fish were fringe-tails, Moors, and telescopes and were not only kept in a healthy condition but attained considerable growth during the winter. The aquarium was well stocked with ludwigia, anacharis, sagittaria, cabomba, and herpestes.

It is evident that no ironclad rule can be laid down for stocking an aquarium or pool with goldfish, but that one must rely more or less upon his judgment in such matters. A gallon of water, if it contains no aquatic plants, is inadequate for an inch or even a one-half inch goldfish, while in a well balanced aquarium 2 or 3 inches of fish can be safely held in a gallon of water.

LOCATION OF AQUARIUM

In arranging an aquarium a location should be selected where the water will not be subjected to extremes of temperature. If an indoor aquarium is located in a southern window and no shade is provided, the temperature of the water will run exceedingly high and at times it may become deficient in oxygen.

Aquatic plants, when growing, utilize carbonic acid gas and give off oxygen, as evidenced by the myriads of tiny bubbles that may be

een through the water. The growth is during daylight, especially hen the sun is shining on the aquarium. However, at night or on loudy days, when plants do not grow, they are of no special value s oxygenators. On the other hand the decaying branches may bsorb the oxygen from the water. It is for this reason that in an quarium, apparently well balanced, fish come to the surface and ulp air on cloudy days and nights.

By experimenting in the home, one may find a suitable location or an aquarium—one where the minimum amount of work will be equired to keep it at all times in a presentable condition.

Algæ grow profusely in sunlight; and while a certain amount of is necessary in an aquarium, the idea is to find a place where just he right amount will be roduced. Snails are valuble in keeping down algæ, ut an aquarium would have o be heavily stocked in rder to keep it in a present-ble condition where there s an unusual amount of unlight.

FIGURE 4.—*Sagittaria natans.* (From "Goldfish varieties and tropical aquarium fishes" by Wm. T. Innes)

WATER

The best water supply for n aquarium is nearly always from a river, pond, or istern, as water from such source conforms more nearly to natural conditions. Excessively hard water, rom whatever source, is undesirable. Mineral requirements should be satisfied referably in the diet rather han by the addition of salts o the water. The demands f both fish and plants for norganic matter are so mall that a reasonable mount of natural crustacean food in the diet should be sufficient to maintain the alance.

TEMPERATURE

The temperature of the water in an indoor aquarium will range rom 50 to 80° F. in winter and from 65 to 80° F. in summer. A emperature somewhat in excess of 85° should not prove harmful if he water is well aerated, but if the fish show signs of distress their ondition may be improved by reducing the number in the aquarium. n all cases avoid sudden changes in water temperature.

PREVENTION OF ACID CONDITION

For the prevention of an acid condition, which is usually brought about by the decomposition of plants or surplus food, introduce into the aquarium several oyster shells, lumps of limestone, or marble. There is no danger of getting the water too alkaline by the use of these substances, which are soluble only when in contact with the acid from decomposing matter. When the shells, limestone, etc., dissolve quickly it is a sure sign of acid condition. Where snails are introduced, the calcium is necessary for their shell formation.

FIGURE 5.—*Ludwigia glandulosa.* (From "Goldfish varieties and tropical aquarium fishes" by Wm. T. Innes)

FOOD

Most aquarium fishes desire a variety of foods, and the aquarist should endeavor to imitate nature. Whatever foods are used it should always be borne in mind that a balance of vegetable, animal, and mineral content is required. The best prepared foods are those that are granular in form and usually of dark color. Such foods may be purchased at pet stores and contain a mixture of flour, fish roe, meat, etc. Dried bread crumbs are frequently recommended as food for goldfish, especially when whole wheat bread is used.

Goldfish in an aquarium should be fed every day in summer and every other day in winter. Natural foods, such as small Crustacea (Entomostraca) and insects and their larvæ, are most desirable, but many useful substitutes for these foods are available. While such substances as fish roe, fish, ant eggs, rice and pea flours, etc., are recommended in complex formulæ, it should be remembered that the essential requirements—animal and cereal foods—can be simply supplied. For the former lean meat scraped fine, chopped earthworms, fresh or dried liver will serve admirably, while a satisfactory source of the latter is embodied in a flour paste or dough, ground oatmeal, or corn meal. If it is desired, the mineral content may be supplemented by the addition of a little table salt or Epsom salts.

Prepared foods containing many of the ingredients mentioned are for sale in the market, and their use can be recommended to the amateur aquarist. The main thing to guard against is the giving of more than the fish can consume at one feeding, as any excess allowed to remain in the water will eventually pollute it and produce diseased conditions.

Daphnia, popularly known as "water fleas," are an excellent live food for goldfish. The same may be said with reference to larvæ

of the mosquito, which can be had in large quantities during the summer months and may be found in rain barrels or stagnant pools, the common name being "wrigglers."

DISEASES AND THEIR TREATMENT

Illness among goldfish becomes apparent in many ways, but as a usual thing the fins are bloodshot, the dorsal fin droops, and the affected fish is inclined to rest on the floor of the aquarium, with little or no desire for food. Where only one fish is diseased the cause may be attributed to overfeeding or constipation, but if a number are ill it is an indication that something is radically wrong, either with the food, the water, the oxygen supply, or the temperature conditions.

The excrement in health is dark, either a brownish green or black. If white or yellow, it indicates overfeeding. When a fish becomes diseased it should be removed from the aquarium immediately.

Goldfish must be handled gently and as little as possible to avoid injury to their scales, fins, or tails. The dip net used for their transfer to and from the aquarium should be round and somewhat deep rather than funnel-shaped. If it can be avoided, fish should never be grasped with the hands.

When the fish are in a weakened condition or have been bruised by excessive handling diseases known as "white fungus" and "tail rot" will often develop on the body and fins. When a whitish coating or splitting of the fins is noted the affected fish should be placed in another jar containing water just salty enough to be noticeable to the taste and kept there until cured, the salt water being changed daily. This treatment is good for run-down fish as well as for those that are diseased.

FIGURE 6.—*Herpestis amplexicaulus*. (From "Goldfish varieties and tropical aquarium fishes" by Wm. T. Innes)

To overcome constipation dissolve a tablespoonful of Epsom salts in a gallon of water and allow the fish to remain in the solution for a few hours if necessary. Then let them rest a day or two in a mild solution of Epsom salts with a little sea salt added. Constipation can be prevented by the use of live foods, such as Daphnia, at intervals.

On cloudy days, even in well-conditioned aquaria, fishes will come to the surface of the water to breathe, but if they do this in clear weather it is a sign that something is wrong. The trouble may be due to one of the following causes: Too few plants, too high temperature, infected gills, or decomposition of unconsumed food. The cause should be found and removed as quickly as possible.

Goldfish are subject to many diseases not described in this publication, among them being inflammation of the eyes, an affection of the swimming bladder, and the infestations of numerous parasites, both internal and external. The former are beyond treatment, but for many of the latter the salt treatment is efficacious.

WHITE FUNGUS

White fungus results from numerous causes such as lack of oxygen, sudden changes of temperature, decaying food in the water, rough handling, etc. Daily treatments in weak permanganate solution, 20 small crystals to a gallon of water, or the dilute salt solution is recommended for soft-scaled fishes like goldfishes. For fishes with tough scales salt treatment should give the best results, and in some instances it is necessary to use the strong salt solution, although great care should be used in administering this treatment. When the fungus is attached to the body away from the head a good plan is to dip the affected part into a 50 per cent solution of peroxide of hydrogen, keeping the fish's gills moist while the operation is in progress. When fungus reaches the gills it is almost impossible to effect a cure.

TREATMENT WITH STRONG SALT SOLUTION

A solution containing 13 ounces of Turks Island salt per gallon of water is prepared. If this is not available, common salt may be substituted. The fish are dipped up in a deep net and lowered in the salt solution, where they should remain for two or three seconds. The fish are then transferred to another vessel containing well-aerated water of the same temperature as that from which they were taken. This treatment may be profitably repeated daily for two or three days.

TREATMENT WITH DILUTE SALT SOLUTION

In this case the fish are placed in a 3 per cent solution of common table salt, one-fourth pound to a gallon of water, and allowed to remain in the bath with aeration of the solution for 30 minutes. The fish may then be placed in another vessel containing well-aerated water. If the fish show signs of distress during the half-hour—by turning on one side—they should be removed to fresh water. The treatment may be repeated on the following two or three days.

WEAK SALT SOLUTION

A simple and effective treatment for ridding fish of parasites and curing fungus, etc., is to place the affected fish in a solution of salt water for a week or 10 days. Practically any fish can stand this treatment. The solution should be renewed every two to three days, and in changing the fish to a fresh solution sudden changes of temperature should be avoided. The water may be aerated by dipping up and pouring back three or four times as occasion may require. Formula: Half ounce of coarse salt, such as is used for freezing ice cream, to 1 gallon of water.

FIN CONGESTION AND TAIL ROT

This disease is an ailment frequently met with in aquarium fishes and often occurs after the introduction of new plants or fishes, or it may be caused by poor conditions in the aquarium—too many

hes or overfeeding. The disease is contagious. Treatment: Place h in a permanganate bath for 15 minutes. The solution should 5 small crystals to 1 quart of water. The weak salt solution eviously described may be used in place of this.

INDIGESTION

The symptoms of indigestion are as follows: The fish becomes zzy, loses its equilibrium, and stands on its head or lies on the ttom of the aquarium. For this trouble the salt-bath treatment s been found very beneficial, also a slight rise of the water tem- rature. Indigestion is usually caused by feeding with too much epared food and not enough animal food. It is always well to derfeed rather than overfeed fishes. Fishes suffering from indi- stion recover quicker if given more swimming space for a few days.

ICHTHYOPHTHIRIUS

The first symptoms of the presence of Ichthyophthirius are the eer actions of the fish and the appearance of small whitish-gray, arply defined pimples sticking out over the surface of the body. hen the fish are first infected they rub themselves continually gainst the bottom and sides of the tank in an attempt to brush off e young parasite. In a short time they will be seen to hang list- ssly in the water, with drooping fins, or gasping at the surface, e to the impaired condition of the gills. All parts of the body, ead, sides, fins, and especially the mouth and gills, may be heavily fected by these organisms.

As the parasite grows it becomes visible as a raised light-colored ot on the fish, and if these are numerous the adjacent ones may uch each other and unite to form a large spot, giving the skin a ottled appearance. As the disease spreads the raised spots often cur by the hundreds and the thousands, covering the entire exter- al surface of the fish. Fish that become heavily infected soon stop ting, and in the last stages of the disease they are covered with a eavy slime and red blotches or "scalded" areas. Fungus soon evelops on the raw parts of the fins and body, and the fish live t a short time.

The most practical method of treating the disease consists in moving or destroying the large adult parasites after they have opped off the fish. This may be accomplished by placing the fish a swiftly running water, which carries away the parasites before ey have time to multiply and reinfect the fish. Long troughs or lindrical tanks can be easily equipped for this purpose. The treat- ent may be made even more positive by scrubbing the trough or nk every day with a strong salt solution after removing the fish. n warm weather infected fish may be cured by this method in 7 to 0 days, and further epidemics can be prevented by quarantining ewly brought in stock in this way. Successful treatment in any se depends upon combating the disease when the first symptoms re noticed and continuing it until all the parasites have had a hance to drop from the fish.

Nets and siphons used around infected fish should be sterilized each time they are used in a strong brine solution, lest the parasites be transferred to other tanks. Detailed information on this disease may be obtained by consulting Bureau of Fisheries Document No. 959.

It is not possible to enter into details concerning these diseases and their treatment. Further information on the subject may be obtained from the standard books on goldfish culture, a selected list of which is herewith appended. Many of these books may be consulted at the public libraries.

HOW TO DISTINGUISH SEX

In goldfish, as well as in other fishes, the male and female are so similar in external appearance that the sex can be determined only by an examination of the internal sexual organs. The following extract from Aquatic Life will be of interest to amateur aquarists:

Quite the first question to be asked by one desiring to breed goldfish is how the sexes may be distinguished. It has been shown that a slight difference in contour exists in the region about the anus, but it is exceedingly hard to discern, and not a few experienced fanciers will refuse to guarantee the sex of a fish based on this feature alone.

When in condition to breed, the distinguishing points are very evident. The male develops tubercles or "salt spots" on the gill plates and along the first ray of the pectoral fins. These marks may be absent from the fins and but few in number on the gill plates. The tubercles are usually considered an infallible distinction, but are not absolutely so. Once in a lifetime a fancier may find a female with tubercles.

The female, except about the anus, exhibits no sexual difference until the development of the roes causes a distention of the body, which is more evident from a top view than from the side. Other than this it possesses no characters to distinguish it from the male. If both sexes are in the same tank, precocious males may "drive" barren females, and in that manner aid in identification, but a doubt may be cast on the certainty of it by the fact that males will sometimes drive other males.

REARING YOUNG GOLDFISH

As goldfish sometimes spawn in aquaria, the following advice is given for the benefit of those who may desire to protect the eggs and rear the resulting fry.

Goldfish begin breeding in their second year, and while they may continue to reproduce for six or seven years they yield the maximum number of eggs in their third and fourth years. When the male fish begins to follow the female about the aquarium it may be assumed that spawning will occur very soon. The fish may be allowed to remain in the aquarium and the eggs removed later, or they may be transferred to another tank which has been specially prepared with suitable aquatic plants to receive the eggs. In stocking the aquarium with aquatic plants care should be taken to see that they contain no snails or other enemies of fish eggs.

The female deposits the spawn on the leaves and roots of aquatic plants, the mucilaginous covering of the egg causing them to adhere to the plants, where they are fertilized by the male fish. The plants preferable for the purpose are Myriophyllum and water hyacinth.

Goldfish eggs are about one-sixteenth of an inch in diameter and of a pale amber hue. From 10 to 20 eggs are deposited, and after short

ervals the operation is repeated for several times. As the vegeta-
n becomes covered sprigs of it containing the eggs should be re-
oved and placed in suitable receptacles, which may consist of
ameled pans or tubs. The vessels containing the eggs should be
aced in a strong light and where they will receive sunlight for a
ort time each day. As development proceeds two black spots
pear in each fertilized egg, usually within two or three days after
ubation starts. These are the eyes of the embryo fish.

Young goldfish are very delicate and can not stand much water
essure. For this reason they remain near the surface of the water
d are sometimes killed by even fine drops of water falling on them.
Attached to each little fish at its birth is a yolk sac, which pro-
les it with nourishment for about three days. After the yolk sac
absorbed the young fish subsist on the infusorial organisms found
the water, these being too small to be seen with the unaided eye.
here ponds are accessible small quantities of green water derived
erefrom should be introduced in the tanks, first taking the pre-
ution to strain it through cheesecloth for the removal of any
rger organisms.

To breed infusoria, a quantity of the muck or slime taken from
e bottom of any small pool or stagnant body of water should be
aced in a jar or pan, covered with water, and allowed to stand.
varied growth will result, most of which is valuable in the diet of
ung fish. If no standing pond or ditch water is available a little
y should be placed in a small receptacle, covered with water, and
aced where it will receive only a limited amount of light. Within
short time a scum will appear on the surface, and inside of four
ys myriads of infusoria will have developed. Preparations for
e production of infusoria, as well as the dried product, can be
rchased from dealers in aquarium and goldfish supplies.

During the early stages of their existence goldfish should be fed
om six to eight times a day, only a small quantity of food to be
ven at each feeding. In addition to the infusoria the fish may be
ven a small quantity of rice flour, the dust from soda or graham
ackers, or a small amount of blood pressed from raw beef. Other
ceptable foods consist of the yolk of a hard-boiled egg finely di-
ded by straining it through cheesecloth, oatmeal broth, finely
raped beef, or a mixture of dried daphnia and dog biscuit, the
aterials being reduced to a powder and prepared in the proportion
two-thirds daphnia to one-third biscuit. A small amount of
is powder sprinkled on the water two or three times a day will be
gerly taken by the fish. After the first six weeks the fish may be
d on various materials, such as small crustaceans, mosquito larvæ,
oiled and strained oatmeal, and other cereals of any kind. The
mber of feedings may also be gradually decreased until one meal
day is being given at the end of three months.

If collections of crustaceans and mosquito larvæ are made from
nds for a food supply, the material must be carefully strained
rough a fine sieve to obviate the possibility of water beetles, leeches,
d dragon-fly larvæ gaining access to the fish and preying upon
em.

Only a few fish can be reared successfully in an ordinary fish
obe. An attempt to carry as many as 100 newly hatched goldfish

in a gallon of water would result in the gradual disappearance of all the fry. Therefore, if only a small vessel is available for the purpose it would be unwise to attempt to rear more than a dozen fry as the crowding together of an appreciably larger number would undoubtedly end in complete failure.

AQUARIUM CEMENT

In the manufacture and repair of its aquaria the Bureau of Fisheries has for many years successfully used a cement composed of 5 parts of putty, 1 part red lead, and 1 part litharge. These ingredients are mixed to the proper consistency for glazing by the use of boiled linseed oil and a few drops of dryer. A sufficient amount of lampblack is added to change the color from red to slate. After applying the cement allow it to dry thoroughly before putting water in the aquarium.

PONDS

The first requisite for the rearing of goldfish in outside ponds is a temperate climate, one that is not subject to protracted periods of extreme heat or cold. If the work is to be conducted on an efficient basis, a site should be selected in a part of the country having natural conditions similar to those in Maryland, Virginia, New Jersey, and Delaware, where settled weather may be depended upon from about the middle of May to the end of September.

The second factor for consideration is the water supply. This should be constant and under control so far as possible at all times. Too much stress can not be laid upon the importance of the latter point. The pond site should be located where it will not be in the path of destructive freshets, and in the construction of the ponds every effort should be made to bring the supply under complete control. Even under the best of arrangements a sudden downpour of rain will often flood a pond system and cause the loss of fish.

The most favorable source of water supply for a pond system is a good spring, but in its absence successful results may be expected by piping water from a neighboring stream, provided it is of suitable volume for the work and of good quality. The source should be at a sufficient elevation to permit the water to flow by gravity from one pond to the succeeding pond below. In this connection a slight slope in the contour of the pond site is a great advantage, as it is always desirable to provide for a fall of 5 to 6 inches between each pond, thus making it possible to use the same water over and over throughout the series. As a rule the last pond of a series is used for the cultivation of daphnia and other varieties of live fish food.

Some soils are not suited to pond construction, among them being sand and gravel, through which the water seeps rapidly away. The best soil is one with a clay bottom, as this acts to retain water. In the event that a site of this character is not available the excavation may be made slightly deeper than the intended depth of the pond and a 6-inch coating of clay plastered on the sides and bottom. To insure against loss of water through the porous ground near the surface it is advisable to insert boards in the pond margins and fill in the spaces behind them with clay.

All ordinary requirements in goldfish culture will be met by pro-ding three ponds—the first and head of the series to serve as a wning inclosure, the second as a nursery, and the third as a rear-g pond. To these may be added storage and winter ponds, if ired. The spawning pond, which is the first to receive the water pply, may be formed, if desired, by dividing the rearing pond o two compartments. This may be done by fastening 1-inch sh galvanized wire screen to a framework sunk into the mud in bottom of the pond and made to extend about 1 foot above the ter level. One advantage of this arrangement over a separate nd is that any young fish that develop from undiscovered eggs l be saved, the current carrying them from the spawning com-tment into the rearing pond.

The rearing pond should be much larger than the spawning pond. me goldfish breeders recommend an inclosure 8 by 20 feet in area the most suitable for rearing purposes. The floor of this pond uld slope from a water depth of 6 inches at one end to 24 inches the opposite end, with the deepest part at the outlet to permit of wing off the water when desired. Suitable plants should be ted in the soil of this pond. Aquatic vegetation serves to oxygen-the water and also provides excellent hiding places for small fish l attracts insect life, thus constituting a source of supply of natural d for the fish.

Being required merely for the holding of fish intended for sale, size of the storage pond should be governed by the requirements this respect. Other than this its mode of construction need not fer materially from that of the other ponds.

The winter pond, whose purpose is the carrying of brood fish ring cold weather, should be located near the spring or other rce of water supply to prevent freezing, and when stocked with it should be kept under careful observation so that any ice form-g on the surface may be promptly broken. If the weather is not cold, goldfish may be held in open ponds throughout the year. a severe climate the brood stock may be transferred indoors and d in barrels or tanks. Being very inactive during the winter they quire but little food. It is said that a compartment 4 by 8 feet l 4 feet deep will carry approximately 50 fish 8 to 10 inches long ughout the winter.

GARDEN POOLS

It is generally admitted that concrete is the best material to use the construction of an outside pool. The walls should be about nches thick and reinforced with pieces of iron. In mixing cement a water-tight job of this kind it should be made rather rich, about part of cement to 2 parts of sand and 4 parts coarse gravel, both sand and gravel to be well washed. The pool should be about inches deep at its center, tapering to 18 inches at the sides.

The process of pouring the cement should be continuous, for if job is started and delayed for any length of time there is always eam where the new cement is poured that will in all probability se leakage. After the cement is poured it should be finished with nixture consisting of one-half cement and one-half sand. Ordi-rily a pool constructed in this manner will retain water. However,

should any seepage occur it can be stopped by roiling the water, the particles of dirt filling the pores of the cement; or by the application of one of the water-proofing preparations recommended by your local dealer in aquarium accessories.

After the pool is completed it should be filled with water and allowed to stand for three or four days; then drain off the water place 2 inches of sand in the bottom, stock with aquatic plants such as anacharis, cabomba, sagittaria, ludwigia, etc., refill with water and allow it to stand four or five days before introducing the fish. The danger of introducing fish too quickly into new concrete pools is that the water becomes impregnated with lime from the new cement work. When water is allowed to stand four or five days in a pool and a scum collects on the concrete work it is safe to introduce goldfish, especially when there are plenty of aquatic plants.

If it is not the intention to have emergent plants in the pool, it is well to locate it where it will be under the shade of trees most of the day. However, if water lilies are to be grown it is very important that the pool be located where it will have the maximum amount of sunlight, as it is generally admitted that three things are essential for growing water lilies—good soil, still water, and sunshine. Even though the pool is placed in the sunlight the growth of algæ will be held in check by a profuse growth of lily pads on the surface of the water.

THE GOLDFISH AS A MOSQUITO EXTERMINATOR

As previously stated in this publication, mosquito larvæ, or wrigglers, constitute an excellent food for goldfish. J. Percy Moore, in Bureau of Fisheries Document No. 923, entitled "Use of Fishes for Control of Mosquitoes in Northern Fresh Waters of the United States," makes the following statement with reference to goldfish:

> In a few small ponds and reservoirs where the shore lines were clean and unobstructed and in which goldfishes only were present the author found practically no mosquito larvæ. This is also frequently the case in fountain basins. In such places there is but little food, and any larvæ that appear are quickly eaten by the hungry fish. For a number of years the author has kept several rain barrels free of mosquito larvæ by placing in each one or two small goldfish. If the fish died or was removed the barrel would be abundantly populated within a few days with wrigglers, usually of *Culex pipiens*, but occasionally of *Aedes triseriatus*. With the replacement of the fish the larvæ quickly vanish. A number of other fishes were tried, but, while not more efficacious, the goldfish lived longer than any of them, often surviving the winters when the water in the barrels did not freeze solid.

The author of this publication has for several years kept a number of tanks in his yard in which are grown water lilies. When there are no goldfish in the tanks the water soon becomes teeming with wrigglers but after the introduction of a few goldfish the wrigglers soon disappeared. A typical example of the value of goldfish for holding mosquitos in check is illustrated by the following: Last summer one of these large tanks was reserved for rearing goldfish. A quantity of aquatic plants containing goldfish eggs were placed in the tank for hatching but in the course of a week or 10 days the tank was alive with mosquito larvæ. This condition continued until the young goldfish were about four weeks old, when a careful examination of the water was made and no mosquito larvæ found.

Goldfish when used for the purpose of holding mosquitos in check ould be fed little or nothing during the mosquito season. Small n invariably produce the best results.

STERILIZING

For sterilizing plants use a weak solution of permanganate of tassium—5 small crystals to 1 quart of water for 10 minutes—shing off the permanganate before placing the plants in the uarium; or use a tablet of bichloride of mercury to 1 gallon of ter.

For sterilizing tanks in which contagious or parasitic diseases have urred, first remove the fish and use one of the following treatnts: Twenty per cent solution of salt; or 1 ounce of copper phate to 100 gallons of water.

INTRODUCTION OF NEW FISHES

It is found that most of the trouble in garden pools and aquaria urs after the introduction of new fishes. This, without doubt, is e to the failure to take proper precautions in the beginning. New hes should be isolated for a week and if they then show signs of sease they should be given for several weeks in succession a bath ting from 15 to 30 minutes in a solution of permanganate of tassium of 5 small crystals to 1 quart of water.

The following fishes can safely be placed with goldfishes: Roaches, iners, suckers, minnows, chubs, small specimens of catfishes, sunhes, and crappie.

CONCLUSION

Cleanliness, good light, plants well distributed over the bottom, oper food in moderate quantity, scavengers, prompt removal of k fish, and avoidance of overstocking are the essential factors for e maintenance of a successful aquarium. Thousands of goldfish ve been killed by lack of observance of a few simple rules, and ny are lost through mistaken kindness. The globe in the sunht is a veritable torture cell. The fact that goldfish can endure great deal in the way of unwholesome environment is not an cuse for torturing them. Moreover, with proper care they will rive and attain a great age.

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